The First Kepler Observations of the Pulsations of an R Coronae Borealis Star.

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K2 will open a new avenue for the detailed study of the pulsations of the R Coronae Borealis (RCB) stars. These observations are key to understanding the evolution of the RCB stars because their masses cannot be accurately estimated estimated by other means. The ~75 days of near continuous, high-precision observations will be the first opportunity to use Kepler to observe the brightness variations of an RCB star. V1157 Sgr is expected to be on silicon during the Field 7 observations. The proposed observations should be at least two orders of magnitude more precise than the best that can be done from the ground, where a typical cadence is once per night and uncertainties are > 0.01 mag. These observations will provide a better understanding of the pulsation mechanisms and modes in RCB stars. RCB stars are thought to be ~0.8-0.9 M(Sun) from previous stellar pulsation modeling. This estimated mass agrees well with the predicted mass of the merger products of a CO- and a He-WD. Final-flash stars, since they are single white dwarfs, should typically have masses of 0.55-0.6 M(Sun). No cool RCB star, with T(eff) = 5000-7000 K, is known to be a binary so these mass estimates are of great importance to understanding the evolution of these enigmatic stars.

RCB stars show periodic or semi-periodic light and radial velocity fluctuations due to both radial and non-radial pulsations. These stars show pulsation periods in the 40-100 d range. These variations are separate from the large declines in brightness caused by dust forming around the star. The pulsations in RCB stars are thought to arise through strange-mode instabilities. Strange modes occur in stars with high luminosity where radiation pressure dominates.

RCB stars comprise a peculiar and rare class of stars that offers an excellent opportunity to reveal crucial insights into the advanced stages of stellar evolution. The first star of this class, R Coronae Borealis (R CrB), was discovered to be variable over two centuries ago. Today, the known population of RCB stars is now ~100 stars in the Galaxy. RCB stars form a class of cool, carbon-rich supergiants that have almost no hydrogen. They undergo extreme, irregular declines in brightness, of up to 9 magnitudes, due to the formation of thick clouds of carbon dust. Two scenarios have been proposed for the origin of an RCB star: the Double Degenerate and the final helium-shell flash models. The former involves the merger of a CO- and a He-WD. In the latter, a star evolving from a planetary nebula central star expands to supergiant size.

Our proposed target, V1157 Sgr was identified as an RCB star fairly recently in 1991. Its spectrum, lightcurve, and IR excess show it to be a typical cool RCB star with a T(eff)~5500 K. V1157 Sgr shows low-amplitude pulsations (delta V~0.2 mag) with a period of ~40 d.The pulsations of V1157 Sgr have not been studied previously. The duration of the K2 monitoring is useful since it will cover almost two complete pulsation cycles for V1157 Sgr. We plan to analyze the pulsations in the new K2 lightcurve of V1157 Sgr using the our codes to model the radial and non-radial strange modes. This project will establish the usefulness of observing RCB stars with K2. If successful, we intend to propose to observe several additional RCB stars which lie in Field 9. The study of the pulsations of RCB stars will be crucial in helping to distinguish between the WD merger and final flash scenarios.